

Short Report: Prevalence of *Strongyloides stercoralis* Antibodies among a Rural Appalachian Population—Kentucky, 2013

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Abstract. We investigated whether *Strongyloides* infection remains endemic in rural Kentucky's Appalachian regions; 7 of 378 (1.9%) participants tested positive for *Strongyloides* antibodies. We identified no statistically significant association between a positive test and travel to a known endemic country ($P = 0.58$), indicating that transmission in rural Kentucky might be ongoing.

BRIEF REPORT

Strongyloides stercoralis infections occur in many countries around the world and are most prevalent in tropical environments with limited sanitation.¹ In the United States, endemic infection prevalence has not been quantified since the early 1980s,^{2,3} when studies in the Appalachia regions of Kentucky, West Virginia, Georgia, and Tennessee reported the prevalence of *S. stercoralis* infection as approximately 3.0% among children residing in those regions.⁴ Children can experience substantial consequences of long-term helminth infection, including stunted growth and delays in cognitive development, which affect school performance and future earning potential.^{5–7} *S. stercoralis* infection can remain latent for decades; life-threatening systemic hyperinfection can occur when an infected person becomes immunocompromised by medications or other conditions.⁸ Strongyloidiasis deaths in the United States during 1991–2006 occurred in people with a median age of 66 years and mainly among white men born in the Southeast who had immunosuppressive conditions.⁸

S. stercoralis infection occurs through exposure to stool-contaminated soil by either ingesting or skin contact with soil containing larvae. Risk for transmission increases if infected persons use outdoor toilets, which may have inadequate sewage disposal and fecal management, thus transmitting infection to others through exposure to contaminated soil during work or play. Prevalence of these infections in the United States might have decreased through time as a result of improvements in sanitation⁹; however, this assumption has not been tested. Rural populations in the United States, where infections are most likely to continue, are difficult to reach and less likely than others to access medical care.¹⁰

Remote Area Medical (RAM; Knoxville, TN) clinics provide free medical, dental, and vision services to underserved populations; residents of these communities have a high historical prevalence of parasitic infections.⁴ Kentucky RAM mobile clinics were held in two rural Appalachian communities over one weekend each in 2013. We conducted a cross-sectional study of *S. stercoralis* antibody positivity among RAM clinic patients to identify risk factors for infec-

tion and determine whether additional more comprehensive studies are warranted. We previously published results of the first weekend clinic, finding *S. stercoralis* antibodies in 5 of 102 participants tested (5% prevalence).¹¹ Below, we present the results from both Kentucky clinics.

The study was approved by the Institutional Review Boards of the Kentucky Cabinet for Health and Family Services and the Centers for Disease Control and Prevention. All RAM clinic attendees were approached on entry to the clinic and invited to participate in the study. Participants aged ≥ 18 years old provided written consent, and parents or guardians provided written consent for participants aged < 18 years old. We administered a risk factor questionnaire through person-to-person interview that requested the following demographic information: age, sex, travel history (including military service), and type of toilet at their residence. The survey data and test results were entered into a Microsoft Access (Microsoft Corp., Redmond, WA) database and imported into SAS 9.3 (SAS Institute, Inc., Cary, NC). Fisher's exact test and Student's t test were used to compare dichotomous and continuous outcomes, respectively.

Approximately 100 μ L blood for serum isolation was collected at the time of survey administration by finger stick. Samples were stored in a cooler for ≤ 48 hours and then brought to the laboratory of the Centers for Disease Control and Prevention (CDC) for *S. stercoralis* antibody testing. Two tests were used: the crude antigen enzyme-linked immunosorbent assay (CrAg ELISA) and the NIE immunoassay (using the MagPlex technology; Luminex Corp., Austin, TX) recently developed at the CDC. In the validation testing by the CDC, the CrAg ELISA had a slightly higher sensitivity (96% versus 93%, respectively) and a similarly high specificity (98% versus 97%, respectively). Positive results are consistent with current or previous *S. stercoralis* infection but do not differentiate between the two infections. All samples from the first weekend clinic were tested on both assays, whereas samples from the second clinic were only tested on the MagPlex immunoassay. Serum samples with discrepant results between tests were rerun on both assays, and if a positive result was repeated on either test, the result was reported as positive. The CDC notified all study participants of their test results and ensured access to free treatment as necessary.

Overall, 24% of RAM clinic attendees (381 of 1,584) participated in our study. Of these participants, a serum sample laboratory result was available for 99% ($N = 378$). The median age of participants for whom laboratory results were

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TABLE 1

Characteristics of study participants stratified by *S. stercoralis* antibody test results in Kentucky in 2013

	<i>S. stercoralis</i> antibody test results		<i>P</i> value
	Positive	Negative	
Demographics	7	371	
Age (years), median (range)	49 (21–69)	45.5 (3–79)	0.47
Female, <i>n</i> (%)	6 (86)	248 (67)	0.43
Risk factors, <i>n</i> (%)			
Born in the United States	7 (100)	364 (98)	1.0
Travel to <i>Strongyloides</i> -endemic area*	1 (14)	46 (13)	0.58
Only indoor flush toilet	6 (86)	362 (98)	0.17
Any outdoor toilet use	1 (14)	7 (2)	0.14

* Based on information available at <http://www.stanford.edu/class/humbio103/ParaSites2006/Strongyloidiasis/epidemiology.html>.

available was 46 years old (range = 3–79 years old), and 67% (*N* = 254) were female. Only 2.1% (*N* = 8) of respondents used an outdoor toilet. Ninety-six percent (*N* = 364) were born in the United States; 12% (*N* = 47) of participants reported lifetime travel to an *S. stercoralis*-endemic country (Table 1).

Only 1.9% of participants (*N* = 7) tested positive for evidence of current or previous *Strongyloides* infection, including one participant who had traveled to a country currently known to be endemic for this parasite (Table 1); 1 of 7 (14%) participants who tested positive and 7 of 371 (2%) participants who tested negative reported using an outdoor toilet (*P* = 0.14) (Table 1). Also of note is that two positive participants were younger than 35 years old (21 and 31 years old with no travel reported) or 29% of positives. These participants had to have been infected in the past two to three decades. Because 127 or 34% of total participants were also under age 35 years and because ages were not significantly different between positives and negatives (Table 1), the percentage of infected participants under 35 years old is proportionate and provides no evidence for increasing or decreasing incidence, although numbers are too small to draw conclusions. The fact that they were identified in this relatively small study prevents us from concluding that transmission is not ongoing and that *S. stercoralis* is no longer endemic in the region.

On the basis of these findings, concern exists that residents in remote areas of Kentucky continue to be exposed to *S. stercoralis*. Additional research should be conducted in rural Appalachian communities to quantify the ongoing burden of and risk factors associated with infection to provide treatment to those infected and education for prevention for those at highest risk.

Received May 19, 2014. Accepted for publication July 28, 2014.

Published online August 25, 2014.

Acknowledgments: We thank Kentucky Remote Area Medical for their cooperation and kind assistance during the study.

Financial support: C.D. acknowledges travel support from an Institutional Development Award (IDeA) from National Institute of General Medical Sciences, National Institutes of Health Grant 5P20GM103436-13.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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